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Economic Research Service

Program of Research on the Economics of Invasive Species Management

Fiscal 2003-2005 Activities

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Program of Research on the Economics of Invasive Species Management

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Chapter 1: Program of Research on the Economics of Invasive Species Management

In 2003, USDA's Economic Research Service (ERS) initiated the Program of Research on the Economics of Invasive Species Management (PREISM) to examine the economics of managing invasive pests in increasingly global agricultural markets. PREISM is national in scope and focuses on decision-making related to species of agricultural or USDA program significance.

Invasive species are defined broadly to include any vertebrate, invertebrate, weed, fungus, plant disease, livestock disease, or other organism that meets the following criteria:

- Is nonnative, alien, or exotic to the ecosystem where it exists or potentially could be introduced—including agricultural, range, and forest ecosystems; and
- When introduced, causes, or is likely to cause, economic or environmental harm.

Invasive species can inflict losses on U.S. agriculture by reducing crop and livestock production, increasing food prices faced by consumers, or undermining export potential, and they can damage environmental or resource values. In the face of this issue, crucial public policy questions have arisen:

- How should resources be allocated among exclusion, surveillance, control, and mitigation programs?
- Which pests should be excluded or controlled?
- What type of exclusion or control approach should be used (such as monitoring, eradication, containment, or long-term areawide management programs)?
- When and where should the approach be used?
- What type of practice should be used (such as inspection, pesticide, or biological control)?
- When should the program or use of a practice be terminated?

Research Mission and Program Principles

PREISM's mission is economic research to support the broader effort within USDA to efficiently prevent and manage invasive species for the sake of the competitiveness, safety, and security of the U.S. food and fiber system.

PREISM's goal is a high-quality, multidisciplinary research program to provide analytically based principles, guidelines, and criteria for invasive species policy and program decisionmaking, as well as economic information, modeling systems, and other tools that support the decisionmaking.

The following program principles ensure the integrity, reliability, and usefulness of PREISM research:

- Research that meets the needs of USDA, other Federal and State agencies concerned with invasive species, Congress, and the public.
- Direct involvement of a broad array of public and private entities in research, evaluation, and review efforts.
- Integration of ERS staff in the development, implementation, and accomplishment of research projects.
- Scientifically rigorous studies with verifiable and unbiased results.
- Wide distribution of research findings.

Program at a Glance

Under PREISM, ERS supports and conducts research to improve the economic basis of decisionmaking concerning invasive issues, policies, and programs. Since the inception of PREISM, program themes have included international dimensions of invasive species prevention and management; development and application of methods to analyze important invasive species issues, policies, and programs; and analysis of economic, institutional, and behavioral factors affecting decisions to prevent or manage invasive species.

Funding for Invasive Species Research

A fiscal year 2003 budget initiative established ERS's annual invasive species funding at $2 million. With this funding, ERS seeks to build national capacity for analysis of USDA invasive species program management through extramural research and internal capacity development. PREISM has allocated $3.8 million in fiscal years 2003-05 through its competitive extramural program: $1.6 million in fiscal year 2003, $1.1 million in 2004, and $1.1 million in 2005. Funding for intramural research has supported management of the PREISM extramural program, as well as other research activities. PREISM activities that have strengthened USDA's internal analytical capability include research targeted toward specific program agency needs, such as estimation of price elasticities of demand and supply, and the development of models capable of analyzing invasive species in general and specific cases.

Interactions With Other USDA Agencies

Program priorities have been selected annually through extensive consultation with the Animal and Plant Health Inspection Service (APHIS), the

Office of Budget and Program Analysis (OBPA), and other USDA agencies with responsibility for program management.

ERS researchers have met with staff from other agencies to share research findings and identify possible topics for collaborative research. For example, ERS economists worked with APHIS, Agricultural Research Service (ARS), and Cooperative State Research, Education, and Extension Service (CSREES) researchers on an analysis of the economic and policy implications of windborne entry of soybean rust into the United States. Also, annual workshops with the PREISM awardees provide opportunities for intensive discussions between researchers and staff from APHIS, the Office of Risk Assessment and Cost-Benefit Analysis (ORACBA), ARS, and various Department of Interior agencies.

To strengthen Federal coordination of invasive species research, ERS convened an informal committee of economists analyzing invasive species issues from USDA and other departments, including the Forest Service (FS), APHIS, Natural Resources Conservation Service (NRCS), ORACBA, U.S. Geological Survey (USGS), and Environmental Protection Agency (EPA). Quarterly meetings since May 2003 have provided a forum to discuss ongoing activities and present current analyses.

Research Dissemination and Outreach

PREISM uses numerous outlets to disseminate research findings to a diverse audience. Final extramural project reports may be made available on the ERS website (www.ers.usda.gov). Some extramural project reports, as well as reports of intramural research, may be published as Economic Research Reports, Economic Information Bulletins, Economic Briefs, or articles in Amber Waves, ERS's flagship publication. Project findings will also be presented in a series of policy briefs.

Results of PREISM extramural and intramural research targeted to narrower, technical audiences are published in professional journals. Researchers also present preliminary results of many extramural and intramural projects at professional meetings and symposia concerning the economics of invasive species.

PREISM's outreach strategy includes a briefing room on the ERS website (www.ers.usda.gov/briefing/invasive species) that reports extramural and intramural program outcomes. Topics include invasive species and their effects on agriculture, exclusion and eradication programs to manage agricultural invasive pests, trends in USDA's emergency program expenditures, and Federal and international programs and policies that affect agricultural invasive species. The briefing room showcases ERS research, including the study of the economic implications of windborne entry of soybean rust in the United States, and timely updates on the PREISM competitive grants program.

Key Accomplishments

PREISM intramural and extramural research has provided critical data, developed decision tools for ranking policy and program priorities, and conducted economic analysis to inform policy and management decisions.

USDA Policy and Program Issues

ERS economists and PREISM-funded researchers are addressing several USDA program needs:

Pest Ranking Tool. In 2003, ERS developed a decision tool for APHIS to rank plant pests by program priority. In this tool, pair-wise ranking criteria enable analysts to apply their informed judgments as to how and which factors, such as trade or environmental factors, influence the severity of infestation risk for individual species. APHIS used the tool to identify pests targeted for surveillance and detection in the 2004 and 2005 Federal-State Cooperative Agricultural Pest Survey (CAPS).

Soybean Rust Study. ARS, APHIS, and CSREES conducted major studies to prepare for the windborne entry of Asian soybean rust into the United States. ERS consulted with plant pathologists and other scientists from these agencies and universities as part of a study linking economic and biological data on soybean rust, including data reflecting South America's experience with outbreaks of soybean rust. This multidisciplinary and inter-institutional effort helped establish reasonable assumptions about the implications of Asian soybean rust on agricultural production. ERS disseminated study findings to senior USDA policy officials and congressional staff through a series of briefings.

The ERS study showcases essential elements of an economic risk assessment for any pest or disease. It considers the likelihood of a pest reaching U.S. agricultural production regions through natural means, uncertainties surrounding the effects on agricultural yields and production costs upon arrival of a pest in the United States, varying U.S. regional susceptibilities to pest establishment, effects on commodity prices, and producer and consumer adjustments to changing markets.

ERS Database and Model Development. To meet the needs of APHIS and other agencies for current estimates of parameters for regulatory impact assessment models, ERS commissioned research in fiscal years 2003 and 2004 to estimate supply and demand price elasticities. ERS developed the list of targeted elasticities in consultation with APHIS and focused on horticultural products where the availability of estimates was limited. Findings will be posted on the ERS website via an interactive data product that allows analysts to search for parameters by various criteria.

Risk Mitigation in International Trade. As part of a PREISM-funded project, a Virginia Polytechnic Institute and State University research team collaborated with APHIS to reconsider the agency's avocado trade regulation, as applied to importation from approved orchards and packers in the Mexican State of Michoacán. The team's modeling approach was used to

assess, under the assumption of negligible risk, the effects of expanded Mexican access. The economic model, analysis, and responses to public comments were published with the new regulation [Federal Register, Nov. 30, 2004 (Vol. 69, No. 229), Rules and Regulations, pp. 69747-69774, FR Doc 04-26336].

Policy and Program Implications

PREISM-funded studies are addressing invasive species issues and decisions that have elicited interest from Federal and State policymakers, program managers, and researchers. Examples include the following:

Invasive Species in Hawaii. James Roumasset of the University of Hawaii and Brooks Kaiser of Gettysburg College are examining control strategies for *Miconia calvescens*, an invasive plant established in Hawaii, and the integration of prevention and control strategies for the brown tree snake. The researchers have met with APHIS, the Coordinating Group on Alien Pest Species (CGAPS), an advisor to Hawaii Governor Linda Lingle, the Brown Tree Snake Technical Committee, and Hawaiian county invasive species committees to discuss economic issues related to these invasive species.

Cheatgrass Management on Public Lands. Dennis King and Lisa Wainger of the University of Maryland have been developing tools to quantify economic outcomes of cheatgrass treatment programs. Results are intended to help FS and Bureau of Land Management (BLM) managers weigh the cost effectiveness of various program options and gauge the restorability of sites in a manner that reflects risk-weighted outcomes of treatment. Since cheatgrass control affects fire risk, the analysis has implications for wildfire management decisions. The researchers have met with FS, BLM, USGS, and U.S. Fish and Wildlife Service (FWS) personnel to present preliminary results and respond to suggestions for enhancing the models.

Environmental Assurance Bonding. Michael Thomas of Florida A&M University has worked with the Florida Department of Environmental Protection to demonstrate how the use of environmental assurance bonding and a review protocol can significantly reduce the risk of accidental release of nonindigenous species by individuals or firms engaged in aquaculture. The project focuses on the release of black carp to protect commercially grown catfish from infectious trematodes, a practice under review by the FWS.

California Pesticide Regulation. This University of California-Davis project, led by Colin Carter, is a bioeconomic analysis of the effects on resistance management of current restrictions on insecticides used for whitefly control on California strawberries. The California Department of Pesticide Regulation, which regulates pesticide use in the State, and the California Department of Food and Agriculture have expressed strong interest in the results.

Infectious Wildlife Disease Management. Michigan State University's Richard Horan and Christopher Wolf conducted research on the economics of bovine tuberculosis in Michigan white-tailed deer and cattle and devel-

oped working relationships with researchers and managers at the Michigan Department of Natural Resources. This project tackles a highly relevant policy issue with a new, innovative framework and has high-quality, academic output. Findings have the potential to improve the cost effectiveness of infectious wildlife disease management.

Managing Invasive Plants in National Forests. Bruce Maxwell's team at Montana State University is developing a Geographic Information Systems-based decision support tool to prioritize and improve the efficiency of invasive plant management. The tool will use predictive models and economic tradeoff analysis to quantify invasion potential and the effects on diverse National Forest management objectives. The project targets FS district personnel who plan and supervise management of invasive plants.

Foreign Animal Diseases. This project, led by Philip Paarlberg at Purdue University with collaboration from APHIS-Veterinary Services, is linking a U.S. agricultural sector model to a disease spread model to estimate the impacts of foreign animal diseases on U.S. livestock and related markets. The study is also examining control strategies and recovery in export markets. The study focuses on three important diseases: foot and mouth disease, classical swine fever, and highly pathogenic avian influenza. Upon completion, APHIS will have a model that rapidly estimates the market impacts of disease-related animal cull, export market disruption, or adverse consumer reaction, and can be used in rule making and evaluation of alternative control and surveillance procedures.

Crop Insurance, Hurricanes, and Citrus Canker. This University of California-Davis project, led by Daniel Sumner, examines how farm programs and crop insurance affect invasive species policies, drawing on three case studies: citrus canker, karnal bunt, and foot and mouth disease. The research team has a forthcoming paper discussing the effects of hurricanes on economics and spatial dynamics of citrus canker eradication. The team has discussed this issue with APHIS, which is concerned about the effects of hurricanes in Florida on citrus canker and the implications for evaluations of programs and strategies.

Economic Impacts of Aquatic Invasive Species. In July 2005, the EPA held a workshop to obtain participants' views on conceptual frameworks and bioeconomic tools for estimating market and nonmarket impacts of aquatic invasive species. Several PREISM-funded researchers participated in the workshop, including Rick Horan, Brooks Kaiser, Lars Olson, Jason Shogren, David Finnoff, and Brian Leung.

PREISM, Today and Tomorrow

Since its inception in 2003, PREISM has conducted and supported research to improve the economic basis of program and policy decisionmaking that concerns invasive species of agricultural and USDA-program significance. PREISM will continue to integrate intramural research with its extramural program, enhance the capacity to analyze invasive species issues and related decisionmaking, and disseminate policy-relevant research that informs decisionmakers and the public. The program will seek input from key con-

stituencies, such as policy officials and program and research leaders in USDA agencies, to identify and prioritize research needs and policy issues concerning the prevention and management of invasive species.

Chapter 2: Fiscal 2003-2005 Extramural Research Activities

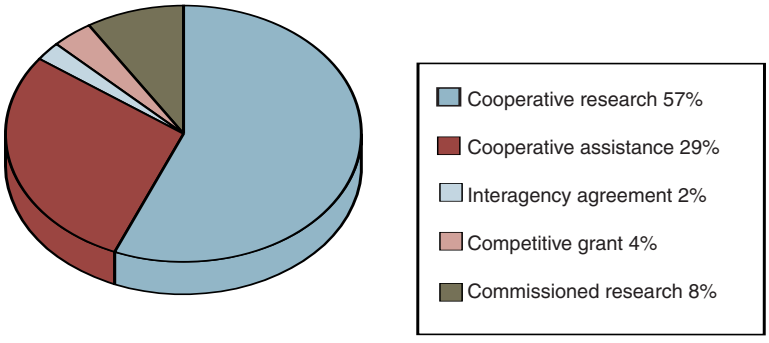
In fiscal years 2003-05, PREISM requested proposals that focused on economic research and/or decision support system development to address USDA invasive species policy and program decisionmaking. Applicants were encouraged to incorporate scientific and technical expertise into their analyses and to have a strong component addressing the economic aspects of space, dynamics, risk, uncertainty, irreversible effects, and institutional frameworks.

The requests for proposals (RFPs) identified priority research areas developed in consultation with agencies concerned with invasive species problems, including APHIS, ARS, FS, and OBPA. Priority research areas changed each year to address new issues identified in those consultations, as well as previously identified issues not addressed by funded projects. Researchers submitted proposals for consideration under specific priority research areas, but many proposals addressed more than one priority research area. Under the competitive funding process, the proposals were peer reviewed by experts from public and private universities and colleges, government agencies, and private research groups. PREISM research priorities, as well as the technical reviews, provided the basis for selecting proposals for funding.

PREISM provides extramural funding through several mechanisms. Over fiscal years 2003-05, PREISM, through its competitive awards program, funded 17 cooperative research agreements, 7 cooperative assistance agreements, 1 interagency agreement, and 1 competitive grant. Under cooperative research agreements, ERS staff and extramural researchers collaborate closely, and both parties contribute to project funding. Under cooperative assistance agreements, extramural researchers are responsible for conducting the greater part of the work.

In addition, PREISM commissioned five studies over fiscal years 2003-05 to address USDA program needs not covered by competitively submitted proposals and to build the capacity of 1890 Institutions to address invasive species issues. Study topics include estimation of supply and demand elastici-

Share of Extramural Awards by Type, Fiscal 2003-2005



ties for horticultural crops, compilation of sanitary and phytosantitary regulations affecting U.S. exporters, development of a framework for determining the level of compensation for livestock producers for disease eradication and containment, and assessment of the potential use of assurance bonds to manage risks of intentional releases of exotic species Total extramural funding for competitive and commissioned research from 2003 to 2005 was about $4.2 million.

Priority Research Areas, Fiscal 2005

In fiscal year 2005, ERS accepted economic research proposals in three areas of importance to USDA's invasive species policies and programs:

I. Institutions and Incentives for Efficient Invasive Species Prevention and Management

Projects in this area examine the interactions between the public sector and groups and individuals in the private sector who act to prevent and manage invasive species; factors that motivate each party to act or fail to act in particular ways; and the incentives created by alternative programs, organizations, or rules. Relevant questions include:

- What is the effect of public and private institutions on invasive species prevention and management?
- What is the effect of strategic behavior on invasive species prevention and management?
- What are the efficiency and equity effects of current and alternative USDA invasive species funding mechanisms?
- How should invasive species regulations be written and enforced, given that contraband can harbor and distribute invasive pests?

II. Practical Decision Analysis for Invasive Species Management

Projects in this area adapt and apply economic and data management tools and techniques to aid, guide, and inform USDA decisions and actions related to invasive species prioritization, detection, monitoring, management, and regulation. Relevant questions include:

- How can economic concepts and decision support models be applied to invasive species decision problems?
- How can USDA evaluate alternative regulations and research investments in a more useful and timely manner, in spite of methodological challenges?

III. International Dimensions of Invasive Species Management

Significant increases in international trade, travel, transport, and tourism over the past decades have created the potential for increased transmission of invasive species. Countries use different approaches to mitigate transboundary risks arising from these activities. Strategies include extra-territorial efforts to control pests and diseases, the regulation of commercial imports by source and product, and border inspections. A network of international organiza-

tions, including the Food and Agriculture Organization of the United Nations (FAO) and other international groups, provide, coordinate, and/or finance regional or multilateral efforts to control invasive species, which complement or supplement national efforts. International negotiations resulted in trade agreements that govern the use of national sanitary and phytosanitary (SPS) regulations that will affect trade. The World Trade Organization (WTO), North American Free Trade Agreement (NAFTA), and other trade regimes set out different options for regulating trade-related risks from invasive species, with different sizes and distributions of costs and benefits across importing and exporting countries. These invasive species policy choices made by national and international authorities affect, and are affected by, production and investment decisions made by firms and private individuals participating in international food and agricultural product markets. Research in this area focuses on economic evaluations of trade-related invasive species risks, as well as firm-level, national, and international strategies for controlling these risks. Relevant questions include:

- What are the international public goods that are related to invasive species management and how might their underprovision be corrected?
- What are the effects of public enforcement of trade-related invasive species regulation?
- What are the firm-level effects of trade-related invasive species risks, regulations, and responses?

Table 1—PREISM Extramural Awards, Fiscal 2005

Research Projects/Awards	Objective	Award
Institutions and Incentives for Efficient Invasive Species Prevention and Management		
Strategic Behavior, Incentives, Heterogeneity and Invasive Species Management Janie M. Chermak *University of New Mexico*	Examine ranchers' incentives for invasive species prevention and management and evaluate potential effectiveness of public prevention and management strategies implemented prior to a critical level of establishment. Develop a spatial, game theoretic model to examine institutions and incentives surrounding Russian knapweed and yellowstarthistle in New Mexico.	**$200,000**
Practical Decision Analysis for Invasive Species Management		
Insect Derivatives: Managing Insect Risk With Financial Instruments Timothy Richards *Arizona State University*	Examine the use of market-traded instruments, known as insect derivatives, as a market-based approach for mitigation of the economic risk of insect damage and as a complement to insurance or public programs. The case study considers whitefly infestation in U.S. cotton.	**$104,000**
The Economics and Ecology of the Risk of Invasive Plant Establishment from the Horticultural Trade in North America Edward Barbier *University of Wyoming*	Develop an integrated economic and ecological analysis of the costs and benefits associated with the risk of invasive plant establishment, where the source of the accidental introduction is the commercial horticultural industry and horticultural trade. Evaluate policies to reduce the risk of accidental introduction, including self-regulation by the industry, taxing or banning the sale of exotic species, and policy coordination between the U.S. and Canadian Governments.	**$207,000**
Value of Animal Traceability Systems in Managing Contagious Animal Diseases Ted Schroeder *Kansas State University*	Construct an intertemporal, spatially disaggregated model of the U.S. beef sector to analyze and simulate responses to an outbreak of foot and mouth disease. Measure benefits, costs, and market impacts of animal identification and traceability programs.	**$152,000**
International Dimensions of Invasive Species Management		
Border Enforcement, Importer Behavior, and Trade-Related Invasive Species Risks David Zilberman *University of California-Berkeley*	Apply an agent-based model to examine how inspection protocols affect export firms' incentives to control or eliminate pests versus their incentives to avoid inspections or hide problems. The theoretical model will incorporate a port selection problem for both inspectors and export firms.	**$132,000**

Table 1—PREISM Extramural Awards, Fiscal 2005—Continued

Research Projects/Awards	Objective	Award
Seed Trade and Invasive Species Risk: Identifying Arbitrary SPS Regulations, Their Cost and Impact on Trade and Welfare John Beghin *Iowa State University*	Investigate how other nations' SPS regulations affect U.S. seed exports. Identify SPS regulations that do not meet international standards, determine the cost associated with the tests, and estimate the effects of removing arbitrary SPS regulations on U.S. seed exports.	**$136,000**
Strategic Policy for Prevention of Invasive Species in Dynamic International Trade Relationships Lars Olson *University of Maryland*	Examine the types of import rules and regulations that would induce exporting firms to voluntarily reduce the risks of exporting exotic species to the United States and the circumstances under which domestic trade policy is required to induce foreign governments to regulate exports. Use a game theoretic approach to examine interactions between private producers in exporting countries and governments of importing countries and between governments of importing and exporting countries.	**$157,000**
Commissioned Research		
The Effects of Foreign Invasive Species Regulations on Markets for U.S. Agricultural Products: Data, Measurement, and Methods Everett Peterson *Virginia Polytechnic Institute and State University*	Develop a database of SPS regulations, as they relate to invasive species, for selected products in international trade of interest to U.S. stakeholders. Since such regulations currently must be obtained from the importing countries, the compilation in a common format will facilitate monitoring and analysis of SPS measures, as well as analysis of SPS policy options.	**$200,000**
Optimal Compensation Schemes for Invasive Species Eradication and Containment in Livestock Andrew Muhammad *Southern University, Baton Rouge*	Provide mechanisms for determining the level of compensation to producers for reporting disease outbreaks in the livestock sector. The project will develop a theoretical model of compensation for pest eradication and containment, apply the model to case studies in the cattle sector, and develop guiding principles and rules for compensating producers in various circumstances.	**$25,000**

Priority Research Areas, Fiscal 2004

In fiscal year 2004, ERS requested proposals in three broad areas. "Stakeholders and Incentives for Efficient Invasive Species Program Management" encompassed such topics as collective action and property rights, the economics of contraband, and moral hazard in public and private sector interaction on invasive species management. "Practical Decision Tools for Invasive Species Management" emphasized developing multicriteria decisionmaking tools, applying standard tools and techniques of economic analysis to the design and implementation of invasive pest programs and policies, and valuing ecological services likely to be affected by invasive agricultural pests of forest, range, and agricultural ecosystems. "Trade and Invasive Species" included economic evaluation of national invasive species regulations on trade in international agricultural markets, economic analysis of international rules and governance frameworks for invasive species regulations, and firm-level analysis of trade-related invasive species risks, regulations, and responses.

Table 2—PREISM Extramural Awards, Fiscal 2004

Research Projects/Awards	Objective	Award
Stakeholders and Incentives for Efficient Invasive Species Program Management		
Determinants and Welfare Implications of Federal and State Noxious Weed Regulations Munisamy Gopinath *Oregon State University*	Evaluation of the impact of noxious weed lists on interstate trade, with a focus on the ecological and economic factors determining which species appear on Federal and State lists and why these vary substantially across jurisdictions.	**$200,000**
Practical Decision Tools for Invasive Species Management		
Developing and Integrating Tools for Assessing the Impacts of Invasive Plants for Prioritization of Management on Federal Lands Bruce D. Maxwell *Montana State University*	Development of a Geographic Information Systems (GIS)-based decision support tool to help land managers prioritize across invasive plant populations, taking into account tradeoffs among ecosystem indicators and control costs U.S. Forest Service land managers are actively engaged in the project as providers of expert opinion and as prospective users of the tools.	**$238,300**
A Risk-Based Approach to Manage Intentional Introduction of Nonnative Species James J. Opaluch *University of Rhode Island*	Development of a risk-based framework to balance potential benefits of intentional nonnative species introduction for commercial purposes against the risks that the species become invasive and cause harm. Research focuses on the case of Asian oysters in the Chesapeake Bay.	**$219,880**
Spatial Management of Invasive Alien Species: An Application to Cheatgrass Management James N. Sanchirico *Resources for the Future*	Development of a stochastic, spatial, and intertemporal bioeconomic model for comparing the costs and benefits of targeting invasive species management actions (such as exclusion, surveillance, control, and mitigation) at various times and locations. The researches are smulating control pollicies, using cheatgrass in the Great Basin as an example.	**$190,860**
Economic Impacts of Foreign Animal Disease Philip L. Paarlberg *Purdue University*	Quantification of the economic impacts of diseases that pose a threat to U.S. livestock and poultry industries. The project will focus on consumer and international trade responses to the presence of such diseases and alternative disease control strategies.	**$169,000**

Table 2—PREISM Extramural Awards, Fiscal 2004—Continued

Research Projects/Awards	Objective	Award
Robust Inspection for Invasive Species with a Limited Budget L. Joe Moffitt *University of Massachusetts, Amherst*	Construction of a decision tool to develop efficient border protection protocols for potentially damaging species under conditions of extreme uncertainty and limited budgets. The project will suggest revisions to the inspections processes in the USDA/APHIS Agricultural Quarantine Inspection Monitoring Handbook, focusing on agricultural inspection at northeastern U.S. ports of entry.	**$125,400**
Trade and Invasive Species		
The Regulation of Invasive Species Introduced Unintentionally Via Maritime Trade Amitrajeet A. Batabyal *Rochester Institute of Technology*	Analysis of economic issues associated with the design and operation of two pest exclusion policy options—port of entry inspections and pre-export certifications—used by USDA	**$74,000**

Priority Research Areas, Fiscal 2003

PREISM identified three priority research areas for fiscal year 2003. "The Economics of Trade and Invasive Species" encompassed economic evaluation of tariff and nontariff barriers to trade in international agricultural markets and analysis of international rules and governance frameworks for invasive species regulation. "Resource Implications of Invasive Species Policy and Program Alternatives" included the following avenues of research: deriving economic implications of alternative approaches to invasive pest exclusion, surveillance, management, and/or compensation; illuminating tradeoffs and informing resource allocation options in the multiprogram context; and exploring the political economy and welfare implications of invasive species regulation. "Bioeconomic Modeling and Risk Analysis" sought to encourage advances in the art and science of bioeconomic modeling; the analysis of externalities, public goods and nonmarket valuation in relation to invasive species; and the incorporation of risk and uncertainty in economic decisionmaking concerning invasive species.

Table 3—PREISM Extramural Awards, Fiscal 2003

Research Projects/Awards	Objective	Award
The Economics of Trade and Invasive Species		
Design of Systems Approaches to Invasive Pest Risk Management David Orden *Virginia Polytechnic Institute and State University*	Formulate an evaluation methodology for regulations that adopt a "systems approach" to reducing invasive pest risks associated with imports. This project is developing a means for determining regulations that achieve appropriate levels of risk protection.	**$108,000**
Modeling the Effects of Invasive Species on the International Trade of Forest Products Jeffrey P. Prestemon and Joseph Buongiorno *USDA Forest Service and University of Wisconsin, Madison*	Examine the economic effects of trade regulations aimed at preventing the accidental importation of potentially forest-damaging invasive species. The research considers the losses incurred by producers and consumers due to timber inventory reductions land supply shifts caused by invasive species, both in the absence of regulation and under phytosanitary regulations that protect forest resources but restrict trade.	**$101,981**
Controlling Exotic Species Introductions: Trade Related Policies and Exposure Christopher J. Costello and Carol McAusland *University of California-Santa Barbara*	Develop theoretical and empirical models to analyze the physical and economic tradeoffs and complementarities between various ex ante policy tools—such as trade bans, port inspections, and pre-export certifications—designed to mitigate the risks associated with invasive species introduced via international trade.	**$68,000**
Resource Implications of Invasive Species Policy and Program Alternatives		
Integrating Prevention and Control of Invasive Species: Lessons from Hawaii James Roumasset and Brooks Kaiser *University of Hawaii* and *Gettysburg College*	Examine the allocation of scarce resources between exclusion and control strategies for different types of pests and provide information to Federal and State decisionmakers. The project employs a dynamic optimal control methodology to examine exclusion and control strategies for three representative pests: an established invader (*Miconia calvescens*), a potentially explosive invader not yet introduced (red imported fire ant), and an eradicable or controllable invader (brown tree snake).	**$200,000**

Table 3—PREISM Extramural Awards, Fiscal 2003–Continued

Research Projects/Awards	Objective	Award
Commodity Programs, Distorted Markets and Economic Consequences of Invasive Species Policies Daniel A. Sumner *University of California-Davis*	Examine the economic implications of invasive species policy within the context of trade and agricultural policies, such as commodity programs and crop insurance. The framework is applied to three invasive pests of particular interest to U.S. agriculture: citrus canker, foot and mouth disease, and karnal bunt.	**$150,000**
Tradeoffs and Resource Allocation Effects for Alternative Invasive Species Management Policies Thomas I. Wahl *Washington State University*	Compare the benefits from trade and potential costs resulting from the establishment of an invasive species. The analysis addresses the economic consequences of alternative response strategies, including prevention and/or control activities carried out in foreign countries, at U.S. ports of entry, and within the United States.	**$100,000**
Bioeconomic Modeling and Risk Analysis		
Integrating Economics and Biology for Bioeconomic Risk Assessment/Management of Invasive Species in Agriculture Jason Shogren *University of Wyoming*	Extend bioeconomic modeling frameworks to improve risk assessments for and policy responses to invasive species that affect U.S. agriculture, with an application to leafy spurge.	**$185,000**
Comparing Cost, Risk, and Benefit Tradeoffs Under Uncertainty: Cheatgrass Case Study Dennis M. King and Lisa Wainger *University of Maryland, Cambridge*	Illustrate practical and credible components of decision support tools to be used in prioritizing regional responses to invasive plants on agricultural and natural lands. The project examines the role of human alteration of landscapes in invasive species diffusion and assesses the potential for spatial (GIS) databases to be used in an analysis of invasions and their potential irreversibility.	**$175,000**

Table 3—PREISM Extramural Awards, Fiscal 2003–Continued

Research Projects/Awards	Objective	Award
Feasibility of Indemnification and Check-off Funded Programs to Manage Invasive Species Risks in Agriculture Barry K. Goodwin *North Carolina State University*	Evaluate economic issues associated with voluntary insurance and mandatory checkoff programs which provide risk management assistance for agricultural producers facing the threat of invasive species. The project includes statistical modeling of the risk associated with three case studies: karnal bunt, Asiatic citrus canker, and Canadian thistle.	**$158,000**
Biology and Economics of Invasive Species: Spatial and Temporal Interactions Colin A. Carter *University of California-Davis*	Examine the spatial and temporal linkages between agricultural markets and invasive species infestations, using greenhouse whitefly infestations of California strawberries as a case study.	**$145,000**
Economics of Managing Infectious Wildlife Disease When Livestock Are at Risk Richard D. Horan *Michigan State University*	Create a modeling framework to account for biological and economic factors that jointly determine how invasive species, wildlife and livestock ecosystems, and human economic activities interact. An empirical application examines economic tradeoffs associated with bovine tuberculosis (TB) control options on and off the farm and compares social incentives with private (that is, farmer and deer hunter) incentives for investing in TB control options and making decisions that affect disease transmission risk.	**$129,000**
Randomly Introduced Biological Invasions: The Economics of Prevention and Control Lars J. Olson *University of Maryland, College Park*	Consider the tradeoffs between prevention, control, and eradication efforts as elements of invasive species policies. This study employs a dynamic optimization framework that incorporates ecological conditions, potential economic damages, and the costs of prevention and control.	**$119,000**
Commissioned Research		
Assurance Bonds as Tool to Manage Risks Associated with Intentional Releases of Exotic Species Michael Thomas *Florida A&M University*	Assess the potential to use assurance bonds to manage the unintended negative economic and environmental impacts of intentional releases of exotic species into the environment.The project examines the release of black carp to protect commercially grown catfish from infectious trematodes.	**$50,000**

Table 3—PREISM Extramural Awards, Fiscal 2003–Continued

Research Projects/Awards	Objective	Award
Estimating Supply, Demand, Import, and Export Elasticities Gary D. Thompson *University of Arizona*	Develop methods, obtain data, and estimate elasticities for citrus and other selected specialty crops.	**$28,500**
Estimating Import and Export Demand for Specialty Crops James L. Seale *University of Florida, Gainesville*	Develop methods, obtain data, and estimate import expenditure and price elasticities for selected products imported into the United States and export expenditure and price elasticities for U.S. products in selected countries. Crops included tomatoes, bell peppers, oranges, grapefruit, apples, bananas, and grapes.	**$22,500**

PREISM-Supported Publications and Other Outputs, Fiscal 2003-2005

The following is a list of output from projects funded by PREISM during fiscal years 2003-05. Three categories are listed: monographs and journal articles; conference presentations; and working papers, discussion papers, and theses.

Monographs and Journal Articles

Acquaye, Albert K. A., Julian M. Alston, Hyunok Lee, and Daniel A. Sumner. "Economic Consequences of Invasive Species Policies in the Presence of Commodity Programs: Theory and Application to Citrus Canker." *Review of Agricultural Economics*, 27(3):498-504, 2005.

Batabyal, Amitrajeet A. "A Research Agenda for the Study of the Regulation of Invasive Species Introduced Unintentionally Via Maritime Trade." *Journal of Economic Research*, 9: 191-216, 2004.

Batabyal, Amitrajeet A., and Hamid Beladi. "International Trade and Biological Invasions: A Queuing Theoretic Analysis of the Prevention Problem." *European Journal of Operational Research*, available online, Nov. 17, 2004. www.sciencedirect.com/science?_ob=MImg&_imagekey=B6VCT-4DTKH0C-2-1&_cdi=5963&_user=1355690&_orig=search&_coverDate=11%2F17%2F2004&_sk=999999999&view=c&wchp=dGLzVlz-zSkWA&md5=15cbed741e18da7e5a00257381fda151&ie=/sdarticle.pdf/. (Accessed October 25, 2005.

Batabyal, Amitrajeet A., and Peter Nijkamp. "On Container- Versus Time-Based Inspection Policies in Invasive Species Management." *Stochastic Environmental Research and Risk Assessment*, Online First, available June 22, 2005. www.springerlink.com/media/pgwf2q5quq1vyn9twc2l/contributions/v/3/7/1/v37115m082805258_html/fulltext.html (accessed October 25, 2005).

Batabyal, Amitrajeet A., Hamid Beladi, and Won W. Koo. "Maritime Trade, Biological Invasions, and the Properties of Alternate Inspection Regimes." *Stochastic Environmental Research and Risk Assessment*, 19(3): 184-190, 2005.

Finnoff, David, and Jason F. Shogren. "Endogenous Risk as a Tool for Nonindigenous Species Management." *Weed Technology*, 18: 1261-1265, 2004.

Finnoff, David, Jason F. Shogren, Brian Leung, and David Lodge. "Risk and Nonindigenous Species Management." *Review of Agricultural Economics*, 27(3): 1-8, 2005.

Horan, Richard D., and Christopher A. Wolf. "The Economics of Managing Infectious Wildlife Disease." *American Journal of Agricultural Economics*, 87(3): 537-551, 2005.

Horan, Richard D., Christopher A. Wolf, Eli P. Fenichel, and Kenneth Mathews, Jr. "Spatial Management of Wildlife Disease." *Review of Agricultural Economics*, 27(3): 483-490, 2005.

Leung, Brian, David Finnoff, Jason F. Shogren, and David M. Lodge. "Managing Invasive Species: Rules of Thumb for Rapid Assessment." *Ecological Economics*, 55 (1): 24-36, 2005.

McAusland, Carol, and Christopher J. Costello. "Avoiding Invasives: Trade-Related Policies for Controlling Unintentional Exotic Species Introductions." *Journal of Environmental Economics and Management*, 48(2): 954-977, 2004.

Moffitt, L. Joe, John K. Stranlund, and Barry C. Field. "Inspections to Avert Terrorism: Robustness Under Severe Uncertainty." *Journal of Homeland Security and Emergency Management*, 2(3), article 3, 17 pp. www.bepress.com/jhsem/vol2/iss3/3/.

Olson, Lars J., and Santanu Roy. "On Prevention and Control of an Uncertain Biological Invasion." *Review of Agricultural Economics*, 27(3), 491-497, 2005.

Conference Presentations

Acquaye, Albert K.A. "Hurricanes and Invasive Species: The Economics and Spatial Dynamics of Eradication Policies." Conference Presentation: Frontis Economics of Plant Health Workshop, Wageningen, The Netherlands, June 1-3, 2005.

Batabyal, Amitrajeet A., and Hamid Beladi. "International Trade and Biological Invasions: A Queuing Theoretic Analysis of the Prevention Problem." Social Science Research Network (SSRN) Working Paper, July 2004 <http://ssrn.com/abstract=569842>. Conference Presentations: Eastern Economic Association 30th Annual Conference, Washington, DC, February 2004; Economics of Invasive Species Workshop, Fargo, ND, April 2004; Canadian Economics Association Annual Meeting, Ryerson University, June 2004; Canadian Agricultural Economics Society-Northeastern Agricultural and Resource Economics Association Annual Meeting, Halifax, NS, Canada, June 2004; American Agricultural Economics Association Annual Meeting, Denver, CO, August 2004.

Batabyal, Amitrajeet A., Gregory DeAngelo, and Surender Kumar. "An Analysis of Economic Cost Minimization and Biological Invasion Damage Control Using the AWQ Criterion." Conference Presentation: Frontis Economics of Plant Health Workshop, Wageningen, The Netherlands, June 1-3, 2005.

Batabyal, Amitrajeet A., Hamid Beladi, and Won W. Koo. "Maritime Trade, Biological Invasions and the Properties of Alternate Inspection Regimes." Social Science Research Network (SSRN) Working Paper, August 2004. http://ssrn.com/abstract=572661/. Conference Presentation: Economics of Invasive Species Workshop, Fargo, ND, April 2004.

Buongiorno, Joseph. "Modeling and Forecasting the International Wood Supply, Forest Stock, and Forest Area (Results for France)." Conference

Presentation: Laboratoire d'Economie Forestiere Seminar on Forest-Wood Sector Modeling, Nancy, France, May 26, 2005.

Buongiorno, Joseph. "An Economic Model of International Wood Supply, Forest Stock, and Forest Area Change." Conference Presentation: International Faustmann Symposium, Baton Rouge, LA, April 20-21, 2005.

Burnett, Kimberly. "Weaker Link Public Goods." Conference Presentations: Northeastern Agricutural and Resource Economics Association Invasive Species Workshop, Annapolis, MD, June 14-15, 2005; Western Economic Association Annual Meetings, San Francisco, CA, July 4-8, 2005.

Burnett, Kimberly, Brooks A. Kaiser, and James A. Roumasset. "Optimal Public Control of Invasive Species: Preventing the Brown Tree Snake (Boiga irregularis) from Invading Hawaii." Poster Presentation: Hawaii Conservation Conference, Honolulu, HI, June 2004. Abstract: www.hawaii.edu/scb/docs/library/2004_abstractsP1.htm#Anchor-ECONOMIC-6296/.

Costello, Christopher J., Carol McAusland, Andrew Solow, and Michael Springborn. "International Trade and the Risk of Biological Invasions." University of California-Santa Barbara Bren School of Environmental Science and Management Working Paper, 2005. www.aere.org/meetings/0506workshop_International_Trade.pdf/. Conference Presentation: Association of Environmental and Resource Economists, Jackson, WY, June 2005.

Diaz, Ricardo, Thomas Wahl, and Zishun Zhao. "The Economic Implications of Invasive Species in International Trade: The Chile—US Fresh Fruit Market." Conference Presentation: Asia-Pacific Economic Cooperation Study Centers Consortium Meeting, Valparaiso, Chile, May 26-29, 2004.

Dougher, Frank L., Lisa J. Rew, and Bruce D. Maxwell. "Scale Effects in the Evaluation of the Spatial Distribution of Non-Native Species in Wildland Ecosystems." Western Society of Weed Science, p. 21. Vancouver, BC, Canada, March 2005.

Fenichel, Eli P., and Richard D. Horan. "Jointly-Determined Ecological Thresholds and Economic Trade-offs in Wildlife Disease Management." Conference Presentation: Seventh Annual BioEcon Conference on "Economics and the Analysis of Ecology and Biodiversity," Kings College, Cambridge, England, September 20-21, 2005.

Fenichel, Eli P., Richard D. Horan, and Christopher A. Wolf. "Wildlife Disease Management Policies Based on Sexual Dimorphism: An Economic Argument." Conference Presentation: The Wildlife Society, Calgary, AB, Canada, September 18-23, 2004.

Fenichel, Eli P., Richard D. Horan, and Christopher A. Wolf. "The Role of Sexual Dimorphism in the Economics of Wildlife Disease Management." Conference Presentation: American Agricultural Economics Association, Denver, CO, August 1-4, 2004.

Goodwin, Barry K., and Nick Piggott. "Spatio-Temporal Modeling of Asian Citrus Canker Risks: Implications for Insurance and Indemnification

Fund Modeling." Conference Presentation: Frontis Economics of Plant Health Workshop, Wageningen, The Netherlands, June 1-3, 2005.

Gramig, Benjamin M., Richard D. Horan, and Christopher A. Wolf. "A Model of Incentive Compatibility under Moral Hazard in Livestock Disease Outbreak Response." Conference Presentation: American Agricultural Economics Association, Providence, RI, July 2005.

Horan, Richard D., and Christopher A. Wolf. "The Economics of Managing Wildlife Disease: Bovine TB in Michigan Deer Populations." Conference Presentation: American Agricultural Economics Association, Montreal, Canada, July 27-30, 2003.

Horan, Richard D., Christopher A. Wolf, Eli P. Fenichel, and Kenneth Mathews, Jr. "Spatial Management of Wildlife Disease." Conference Presentation: American Agricultural Economics Association Sessions of the Allied Social Science Association Meetings, Philadelphia, PA, January 6-9, 2005.

Horan, Richard D., Christopher A. Wolf, Eli P. Fenichel, and Kenneth H. Matthews, Jr. "Wildlife and Livestock Disease Control with Inter-and Intra-Specific Transmission." Conference Presentation: American Agricultural Economics Association, Denver, CO, August 1-4, 2004.

Johnson, Mara, Lisa J. Rew, Bruce D. Maxwell, Fabian Menalled, William Grey, Matthew Kelty and Deborah McCullough. "Synthesis of the Effects of Forest Health Restoration Activities on Non-Indigenous Plant Species." Poster Presentation: Western Society of Weed Science, p. 7. Vancouver, BC, Canada, March 2005.

Kaiser, Brooks A., Kimberly Burnett, James A. Roumasset, and Basharat A. Pitafi. "Control of Invasive Species: Lessons from Miconia in Hawaii." Conference Presentation: Western Economic Association Annual Meetings, San Francisco, CA, July 4-8, 2005.

Kaiser, Brooks A., Kimberly Burnett, James A. Roumasset, and Basharat A. Pitafi. "Integrating Prevention and Control of Invasive Species: Brown Tree Snake." Conference Presentations: Brown Tree Snake Technical Committee Meeting, Honolulu, HI, April 2005; Western Economic Association Annual Meetings, San Francisco, CA, July 4-8, 2005.

Kaiser, Brooks A., Kimberly Burnett, James A. Roumasset, and Basharat A. Pitafi. "Integrating Prevention and Control of Invasive Species: Lessons from Hawaii." Conference Presentations: WEA Annual Meetings, Vancouver, BC, Canada, July 2004; Western Agricultural Economic Association Annual Meetings, Honolulu, HI, June 2004; NAREA Invasive Species Workshop, Annapolis, MD, June 14-15, 2005.

Maxwell, Bruce D., and Lisa J. Rew. "Detecting the Invasion Potential of Non-Indigenous Plant Populations." Invited Speech: Ecology Seminar Series, Pennsylvania State University, April 2005.

Maxwell, Bruce D., and Lisa J. Rew. "Quantifying Invasivness of Plant Populations." Poster Presentation: Western Society of Weed Science, p. 7. Vancouver, BC, Canada, March 2005.

Maxwell, Bruce D., and Lisa J. Rew. "Detecting Invasiveness of Invasive Plant Species." Poster Presentation: WSSA Abstracts 45, p. 60. Honolulu, HI, February 2005.

Maxwell, Bruce D., and Lisa J. Rew. "Plant Invasions: How Should We React?" Invited Speech: Crown of the Continents Annual Meeting, Kalispell, MT, 2005.

McKee, Gregory J., Colin A. Carter, James A. Chalfant, Rachael E. Goodhue, and Frank G. Zalom. "Insecticide Resistance, Population Dynamics, and the Economics of Invasive Species Management." Conference Presentation: Western Agricultural Economics Association, San Francisco, CA, July 2005.

McKee, Gregory J., Colin A. Carter, James A. Chalfant, Rachael E. Goodhue, and Frank G. Zalom. "Economics of Greenhouse Whitefly Management: Costs of Esteem Emergency Regulations." Poster Presentations: Santa Cruz County Strawberry Grower Field Day, Monterey, CA, February 2005; Ventura County Strawberry Grower Field Day, Ventura, CA March 2005; California Agricultural Symposium: Challenges and Opportunities, Sacramento, CA, March, 2005.

McKee, Gregory J., Colin A. Carter, James A. Chalfant, Rachael E. Goodhue, and Frank G. Zalom. "Insecticide Resistance and the Economics of Invasive Species Management." Conference Presentations: Western Agricultural Economics Association, Honolulu, HI, July 2004; Western Economics Association, Vancouver, BC, Canada, July 2004.

Moffitt, L. Joe. "Robust Inspection for Invasive Species With a Limited Budget." Invited Presentation, Frontis Economics of Plant Health Conference, Wageningen, The Netherlands, June 2, 2005.

Opaluch, James J., James L. Anderson, Kurt Schnier, and Meifeng Luo. "A Risk-Based Approach to Managing the Intentional Introduction of Non-Native Species." Conference Presentation: Association of Environmental and Resource Economists Workshop, Grand Teton National Park, WY, June 12-14, 2005.

Orden, David, and Everett B. Peterson. "Science, Opportunity, Traceability, Persistence, and Political Will: Necessary Elements of Opening the U.S. Market to Avocados from Mexico." Conference Presentation: The Role of Labeling in the Governance of Global Trade: The Developing Country Perspective, Center for Development Research (ZEF), Bonn, Germany, March 18-19, 2005.

Peterson, Everett B., Phylo Evangelou, David Orden, and Nishita Bakshi. "An Economic Assessment of Removing the Partial U.S. Import Ban on Fresh Mexican Haas Avocados." Conference Presentation: American Agricultural Economics Association, Denver, CO, August 1-4, 2004.

Pitafi, Basharat A., James A. Roumasset, and Sittidaj Pongkijvorasin. "Management of Renewable Resources Providing Stock Externalities to Other Resource Stocks." Conference Presentations: WEA Annual Meetings, San Francisco, CA, July 4-8, 2005; Hawaii Conservation Conference, Honolulu, HI, July 2005.

Prestemon, Jeffrey P. "The Forest Product Trade Impacts of an Invasive Species: Modeling Structure and Intervention Trade-offs." Conference Presentation: Northeastern Agricultural and Resource Economics Association's Economics of Invasive Species Workshop, Annapolis, MD, June 14-15, 2005.

Rew, Lisa J., and Bruce D. Maxwell. "Surveying and Predicting the Occurrence of Non-Native Plant Species." Invited Speech: Plant Ecology Seminar, Pennsylvania State University, April 2005.

Rew Lisa J., Bruce D. Maxwell, Mark L. Taper, and Richard Aspinall. "Environmental Suitability Patterns and Scale Effects on Non-Indigenous Species Dispersion." Poster Presentation: WSSA Abstracts 45, p. 37. Honolulu, HI, February 2005.

Rew, Lisa J., Mara Johnson, and Bruce D. Maxwell. "Wildfire Management Activities and the Potential for Establishment and Spread of Nonindigenous Plant Species." Western Society of Weed Science, p. 16. Vancouver, BC, Canada, March 2005.

Roumasset, James A., and Basharat A. Pitafi. "The Resource Economics of Invasive Species." Conference Presentations: NAREA Invasive Species Workshop, Annapolis, MD, June 14-15, 2005; WEA Annual Meetings, San Francisco, CA, July 4-8, 2005.

Stranlund, John K. "Info-Gap Inspection." Invited Presentation: Isenberg School of Management, University of Massachusetts, Amherst, March 11, 2005.

Sumner, Daniel A. "Economic Consequences of Invasive Species Policies in the Presence of Commodity Programs: Theory and Application to Citrus Canker." Conference Presentation: Allied Social Sciences Association, Philadelphia, PA, January 7-9, 2005.

Thomas, Michael H. "Evaluating the Decision Process to Restrict Black Carp (Mylopharyngodon piceus) in Aquaculture: Using a Decision Protocol with Assurance Bonding for Releasing Potentially Invasive Exotics." Conference Presentation: World Aquaculture Society, Honolulu, HI, March, 1-5 2005.

Thomas, Michael H., Terrill R. Hanson, and Nick Stratis. "The Use of Environmental Assurance Bonds to Reduce the Establishment and Spread of the Invasive Black Carp." Conference Presentation: Southern Extension Research Activity, Information Group 30 (SERA IEG-30), Tallahassee, FL, May 19, 2005.

Wainger, Lisa A. "Assessing Spatially Heterogeneous Benefits of Ecosystem Services: Identifying High-Payoff Areas for Restoration Investments." Conference Presentation: The Society of Environmental Toxicology and Chemistry Meeting, Baltimore, MD, November 14-16, 2005.

Wainger, Lisa A., Richard N. Mack, Elizabeth W. Price, and Dennis M. King. "Evaluating Economic Risk from Invasive Species and Prioritizing Restoration." Conference Presentation: International Plant Health Risk Analysis Workshop, Niagara Falls, NY, October 24-28, 2005.

Zhao, Zishun. "Modeling the Impacts of Alternative Invasive Species Management Policies on Perennial Fruit Production and Consumption." Conference Presentation: Pacific Northwest Regional Economic Conference, Bellingham, WA, May 19-20, 2005.

Zhao, Zishun. "Modeling the Effects of Alternative Invasive Species Management Policies." Presentation: Centers for Epidemiology & Animal, Veterinary Services, APHIS, USDA, Fort Collins, CO, November 11, 2004.

Zhao, Zishun,Thomas Wahl, and Ricardo Diaz. "Modeling the Impacts of Alternative Invasive Species Management Policies on Livestock Production." Conference Presentation: American Agricultural Economics Association, Denver, CO, August 1-4, 2004.

Zhao, Zishun, Thomas Wahl, and Ricardo Diaz. "Modeling the Impacts of Alternative Invasive Species Management Policies on Perennial Fruit Production and Consumption." Conference Presentation: Western Agricultural Economic Association Annual Meeting, Honolulu, HI, June 30-July 3, 2004.

Zhao, Zishun, Thomas Wahl, and Thomas Marsh. "The Government's Role in Stabilizing Beef Supply When BSE Strikes." Conference Presentation: World Trade Organization Impacts on U.S. Farm Policy, New Orleans, LA, June 1-3, 2005.

Zhao, Zishun, Thomas Wahl, and Thomas Marsh. "Modeling the Impacts of Alternative Invasive Species Management Policies on Livestock Production with an Implementation of Foot-and-Mouth Disease in the U.S. Beef Cattle Industry." Workshop Presentation: NAREA Workshop on Invasive Species, Annapolis, MD, June 14-15, 2005.

Working Papers, Discussion Papers, and Theses

Batabyal, Amitrajeet A. "A Research Agenda for the Study of the Regulation of Invasive Species Introduced Unintentionally Via Maritime Trade." Social Science Research Network (SSRN) Working Paper, June 2004. http://ssrn.com/abstract=560081/.

Batabyal, Amitrajeet A., and Peter Nijkamp. "On Container- Versus Time-Based Inspection Policies in Invasive Species Management." Social Science Research Network (SSRN) Working Paper, May 2005. http://ssrn.com/abstract=715381/.

Burnett, Kimberly. "Spatial Containment of Invasive Species: Insights from Economics." University of Hawaii Working Paper, 2005. homepage.mac.com/ondinebak/HI_Research1_files/spatial-invasives.pdf/.

Fenichel, Eli P. “Bioeconomic Models of Bovine Tuberculosis in Michigan White-Tailed Deer: An Analysis of Ecological Thresholds and Economic Tradeoffs in Wildlife Disease Management.” M.S. Thesis, Department of Agricultural Economics, Michigan State University, 2005.

Kaiser, Brooks A. "Economic Impacts of Non-indigenous Species: Miconia and the Hawaiian Economy." Gettysburg College, Gettysburg, PA, 2005. http://homepage.mac.com/ondinebak/HI_Research1_files/BAKmiconia.pdf/.

Olson, Lars J., and Santanu Roy. "Controlling a Biological Invasion: A Non-Classical Dynamic Economic Model." Working Paper, Department of Agricultural and Resource Economics, University of Maryland, College Park, 2004 < faculty.smu.edu/sroy/Olson%20Roy%20IER%20submission.pdf>.

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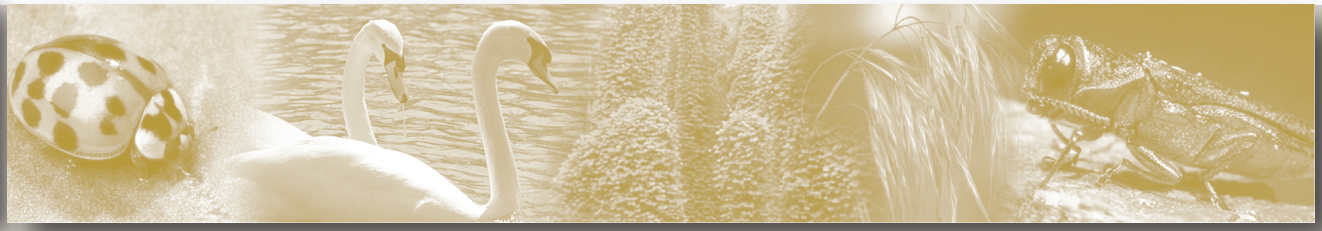

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